

them surpasses all the others, and has an intensity which we may call I. It is situated in the direction A. The next maxima, one on either side of the principal one, have intensity $I/9$, where $I/I = 4/\pi^2$; the next pair beyond these have intensity $I/25$; and so on—the intensities of the lateral maxima decreasing inversely as the squares of the odd numbers. These are consequences of the theory of diffraction gratings. From the above law it follows that the maxima soon become much too faint to be seen by the eye, or to affect a photographic plate, so that what alone can be made visible is the group in the immediate neighbourhood of the position A. This group is what seems to be represented on a very large scale in some of Prof. Michelson's figures, but which in our spectroscopes is so compressed laterally that the whole group appears like one line.

A similar group is necessarily substituted for each physically single line wherever there is one of those limitations of aperture which must occur within the interferometer itself, and, in fact, in every optical instrument. In the astronomical telescope it occasions the spurious disc of a star with its attendant rings. The only question is whether the intervals between the maxima of the group are sufficiently wide to be detected by the interferometer; and as this is simply a question of aperture, or, in the case of a grating, of the number of rulings, it follows that these instrumental groups may be distinguished from physically real groups by the circumstance that the maxima present in them will become more widely spaced if the aperture (or number of rulings) is reduced.

II. *An apparently double line.*—Where the apparatus employed limits the aperture at only one place, the group, which will be substituted for a physically single line, is that described above; at least, if the instrument is in adjustment. But if the arrangements are such as to introduce an actual or virtual limitation of apertures at two places, a double line may result, accompanied by faint appendage lines. What then occurs was discussed in a communication made by the writer to the British Association in 1894 (see Report of the Oxford meeting, p. 583; when also were exhibited examples of such spurious double lines coarse enough to be seen without an interferometer, and where the appendage lines predicted by theory were also seen when the light was intense).

The foregoing instrumental effects arise when the apparatus is accurately collimated. If it be much out of adjustment the groups, substituted for a really single line, are more complicated. But whatever they may be, it is certain that if the resolving power of the interferometer can go sufficiently far, it will bring them into view if they are sufficiently bright to be seen, and that we must then be on our guard against mistaking a resolution of this kind for evidence that the line under examination is physically multiple.

G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N, January 13.

THE remarks put forward by Dr. Stoney are the well-known results of the wave theory, and Prof. Michelson, no doubt, is quite familiar with all that has been said in this department. In addition, he alone is quite familiar with what it is that is actually observed in his interferometer, and therefore must be in a position to give a strong opinion as to whether the observed effects are spurious and due to diffraction or not.

It was with this feeling that I wrote my remarks (p. 228), and I wished to draw some further information from Prof. Michelson on this important subject, rather than in any way to cast doubt on the correctness of his conclusions. I have never worked with the interferometer, and therefore cannot pronounce upon its performance as an optical instrument, but I trust Dr. Stoney's interesting and important observations may have the effect of drawing a full explanation of all the outstanding difficulties.

Bardowie, Orwell Park, Dublin.

THOMAS PRESTON.

A Note on Catching Insects, and the Behaviour of the Bulldog-Ant of South Australia.

DURING my visit to South Australia, I wished to obtain some specimens of the insects of the country, for my naturalist friends at home. At first I experienced considerable difficulty in catching those whose movements were rapid, without injuring their bodies. Recently I have been able to secure nearly every specimen seen, by the following method.

A small antitoxin syringe was charged with benzol, and a small jet of the liquid was directed towards the beast sought for

(a large tarantula, for example); the result of this form of attack was to render the beast almost instantly inert, so that it was easily secured. I am not at all sure that benzol is the best liquid for the purpose; but I used it, as it happened to be the only substance I could obtain, at a distance from a township, which appeared likely to produce the desired effect. I find that insects which could be easily captured a month ago when it was fairly cool, have become wonderfully active now that the sunshine temperature is about 150° to 155° F.

I placed a large bulldog-ant, about one inch in length, in a glass bottle three and a half inches in diameter; I noticed that when the bottle was on its side, and the ant was clinging to the upper surface of the bottle, with its back pointing downwards, that if the ant was detached by a slight jerk, it fell on its feet. I repeated this experiment many times, with seven different bulldog-ants; in every case the ant fell feet downwards, after the well-known manner of a cat.

As I am no naturalist, I may be describing an acrobatic movement of the bulldog-ant already well known to students of natural history. But even should this be so, probably the fact I have mentioned may be of interest to others.

FREDK. J. JERVIS-SMITH.

Quanbi, Mt. Barker, South Australia, December 16, 1898.

A New Dome for Equatorials.

WITH reference to the note in NATURE of January 12 (p. 257), on "A New Dome for Equatorials," allow me to point out that a rotary dome without a shutter was, as far as I know, first constructed for the observatory in Strassburg. The late Prof. Winnecke, at the meeting of astronomers in Berlin on September 5, 1879, referred to it as follows (*Vierteljahrsschrift der Astronomischen Gesellschaft*, 14 Jahrgang, p. 334): "In consequence of the construction of the altazimuth, in which the telescope was placed at the end of the axis, the dome of the north tower had to have an unusually large aperture. This was easily accomplished by employing two separate halves of a hemisphere, which could be rolled back on wheels situated above the circular rail, by which means a complete aperture of 2½ metres could be obtained. The mechanism for the movable parts works easily and surely."

The same construction is described in the *Annalen der Kais. Univ. Sternwarte in Strassburg*, vol. i. p. 7; an illustration of this will be found on Plate vii. (the dome to the left): although both domes—that to the right holding a small refractor, viz. a comet-seeker—are represented as closed, the difference can be seen at once.

I trust that this short historical remark may be mentioned in the next number of NATURE.

E. BECKER.

Kais. Univ. Sternwarte, Strassburg, i. E., January 15.

Luminosity of Sugar.

THE communication of Mr. J. Burke to the British Association, on the luminosity of sugar (NATURE, vol. lvi. p. 533) recalls to my mind an illustration on the large scale of the same interesting phenomenon.

In the process of making what is known as granulated sugar, ordinary refined sugar is passed through a revolving sheet-iron cylinder, where it meets with a current of hot air, and is warmed and dried at the same time. On leaving the drying cylinder the sugar is taken by a travelling band, or other carrier, and dropped into a hopper, from whence it is drawn for packing. The sugar falling into the hopper soon forms a pyramidal heap, and when this is examined in darkness, the top of the heap, where the stream of sugar lands, is seen to glow with a steady light blue luminosity.

On rubbing two pieces of ordinary lump or tablet sugar together, in darkness, the glow is readily produced, and when a piece is broken in two there is a bright flash at the moment of fracture. The light produced in this manner is not affected by moistening the lumps with alcohol, but is intensified when water is used.

When hard lumps of sugar are crushed by striking with any solid body, such as a shovel, the glow appears as a flash, and is easily seen even in the presence of dull light, but is, of course, best viewed in complete darkness. Even a heap of loose sugar responds to a blow from a shovel.

Sometimes sugar, as purchased retail, when left in the bag during dry weather, sets to a hard mass. On scraping such with

a spoon or such-like article the light is readily produced, and when two such masses are rubbed together a very strong glow is the result.

THOS. STEEL.

Colonial Sugar Ref. Co., Ltd., Sydney, N.S.W.

The Wanton Destruction of Rare Visitants to our Shores.

In the *Zoologist* for this month (No. 691) is recorded the destruction and capture of the following rare bird visitants to our shores:—Six crossbills, one goshawk, one flamingo, one little bustard, one great shearwater, one avocet, and two Sclavonian grebes. Is it not time this senseless and unwarrantable destruction of these beautiful creatures ceased? Will you, as the leading scientific journal, lift up your voice against it, and earn the gratitude of every lover of nature?

Rottingdean, Sussex.

E. L. J. RIDSDALE.

EXPERIMENTS ON THE AUTUMN COLOURING OF PLANTS.

THOUGH in the course of the present century a good deal has been written as to the causes of the autumn tints of leaves, our knowledge of this subject is still in a very unsatisfactory condition. The following notes may serve to show the nature of some of the principal factors involved.

While engaged on some osmotic experiments in the summer of 1897, I made the observation that the newly-formed leaves of specimens of *Hydrocharis morsus-ranae*, which had been placed some days previously in a weak solution of cane-sugar, assumed a rich reddish-brown colour, although otherwise perfectly normal. Further experiments showed that the culture of this plant in solutions of cane-sugar, grape-sugar and fructose constantly has this effect on the colouring of those leaves which are developed during the sojourn of the specimens in these solutions, and that even the leaves which were fully developed before the commencement of the experiments gradually become of the same reddish-brown hue.

This colour is due to the appearance of red cell-sap in the palisade-cells, and in the cells lining the air-chambers of the leaf. A certain number of these cells often contain red cell-sap under normal conditions, especially if the plants are strongly insulated, and the temperature of the water in which they are living is somewhat low; but under these conditions, the leaves never assume a colour approaching to that of plants cultivated in sugar solutions. If the sugar solutions are changed often enough, the plants remain perfectly healthy for weeks, and multiply rapidly by means of suckers. In one set of experiments I have followed the development during four successive generations.

In specimens of *Hydrocharis* grown in a good light the leaf-stalks, suckers and roots are usually more or less dotted with red under normal conditions; but the number of cells containing red cell-sap is very much increased in these parts of the plant, if the specimens are cultivated in a sugar solution, even though the conditions of light and temperature are much less favourable for the production of the red pigment than in the specimens grown in pure water.

Salt solutions and the solutions of organic compounds other than the carbohydrates have no such effect on *Hydrocharis*, and even among the sugars galactose is entirely without effect. Lactose acts only after a long period, and the effect is even then very slight and is probably due to hydrolysis.

A few experiments with *Lemna minor* and with *Potamogeton perfoliatus* in solutions of various sugars not leading to similar results, I should probably have laid the whole subject aside, had not my attention shortly afterwards been drawn to the red-colouring of plants in general by a tour in the Upper Engadine just at a time when the autumnal colouring of the Alpine plants was reaching its climax.

There, among the magnificent tints that overspread the mountain slopes, my mind naturally reverted to my laboratory experiments and the possibility of a correlation between the two sets of phenomena suggested itself. Observations and experiments, made upon the spot, led me to the conclusion that there were good grounds for the conjecture that an increase of sugar at the cost of starch might be one of the factors concerned in the formation of the red pigment of those leaves which become red in autumn.

Of such leaves there are two distinct classes. The one set comprises the perennial leaves, and those leaves which, formed during the later part of the summer, remain alive till the following spring or summer. This set of leaves (with the exception of those which die in spring) lose their reddish hues with the return of warmer weather (e.g. holly, ivy). The other set comprises those leaves which fall and die soon after attaining their reddish tints.

Lidforss¹ has drawn attention to the fact that during the winter the leaves of our native plants are entirely devoid of starch, but contain large quantities of sugar. Without a previous knowledge of Lidforss' paper, I obtained the same results and found that the deciduous leaves at the time they assume their autumn tints contain more sugar and less starch than in midsummer.

The remarkable coincidence of the appearance of red cell-sap with the increase of sugar in autumn and its disappearance in spring at a time when the greater part of the sugar in the leaf is recondensed to starch, together with my observations on *Hydrocharis*, formed the starting point for a considerable number of experiments on the formation of the red pigment of leaves.

These experiments and observations have led me to conclusions which may be stated broadly thus:—

The red colouring matters of green plants are probably of the nature of glucosides, and are in most cases unions of tannin compounds with sugar.

The chief physical factors in their production are: (a) sunshine, which on the one hand augments assimilation and the production of sugar, and on the other hand accelerates the chemical process leading to the formation of the pigment; and (b) a low temperature, which prevents the conversion of the sugar into starch. In other words, the red autumnal tints are in great measure the direct result of the autumnal climatic conditions.

It is possible in many plants to produce (red) autumnal tints at any time of the year, by feeding them with glucose.

Generally speaking, this artificial production of red cell-sap is possible only where the natural reddening of the leaf has its seat in the mesophyll cells. In cases where the coloration is in the epidermis, experiments with glucose are unsuccessful.

Among plants especially favourable for experiments on the artificial production of red cell-sap, I may mention various species of *Lilium* (*L. Martagon*, *L. candidum*, *L. umbelliferum*), Holly (*Ilex aquifolium*), various succulent plants, such as *Saxifraga crassifolium*, and among water-plants, besides *Hydrocharis*, the different indigenous species of *Utricularia*.

A full account of these experiments, together with their connection with various phenomena of plant-life, will appear shortly in the *Jahrbücher für wissenschaftliche Botanik*.

E. OVERTON.

THE GREAT CATALOGUE OF BIRDS.

THE recent issue of the twenty-sixth volume of the "Catalogue of Birds in the British Museum"² (the twenty-seventh and concluding volume having been published in advance in 1895) brings to an end a

¹ *Botan. Centralblatt*, Bd. 68, p. 33-44 (1896).

² "Catalogue of the Plateaux. Herodiones, Steganopodes, Pygopodes, Alceæ, and Impennes in the Collection of the British Museum." By R. Bowdler Sharpe and W. R. Ogilvie-Grant. (London, 1898.)